MOBILE RADIO TELECOMMUNICATION SYSTEM
WITH IMPROVED UPLINK RESOURCE ALLOCATION

Cross-Reference To Related Application

This application claims priority of European Patent Application No. 00301166.5, which
was filed on February 15, 2000.

Background of the Invention

1. Field of the Invention

This invention relates to a mobile radio telecommunication system; in such a system, the
method used to allocate resources in the uplink, i.e. in the links to the mobile users, determines
the number of channels which can be simultaneously active in any telecommunications cell.
Limits are set which may be conservative so as to maintain the stability of the system, and also to
ensure that the service provided stays below the maximum outage level allowed in the network.

2. Related Art

In a system operated by Code Division Multiple Access (CDMA) in which traffic is
homogeneous, e.g. it is all voice traffic, and there is a fixed number of channels, the number of
simultaneous links in any telecommunications cell or telecommunications section can be hard
limited, i.e. a definite number can be set.

In a system such as the Universal Mobile Telephone System (UMTS), which is a
heterogeneous system, i.e. the traffic is of a mixed nature, and there is no fixed number of
channels, hard limiting the number of communications links would lead to a very unstable
performance. Also, it would be necessary to change the hard limit and to decrease the number of
links, as the individual data rate of traffic increased, i.e. as there was less spreading gain.

In a wideband system the cell loading is often measured as the "interference above noise
floor". That is, any active mobile user will be generating some amount of interference in the
network and hence increasing the loading in the network. The noise floor is the interference level
when there are no active users in the system.

An improved method of resource allocation suitable for application to a heterogeneous
telecommunications system is desired.

Summary of the Invention

According to the invention, in a wideband mobile radio telecommunication system
having heterogeneous services with different rates, a method of resource allocation characterized
by the steps of determining the current proportions of each rate traffic in a telecommunications
cell; and applying a threshold to the loading level in the cell in accordance with said determined

proportion.

Also according to the invention, a wideband mobile radio telecommunications system comprising a core network, a plurality of radio network controllers each controlling a plurality of base transceiver stations, characterized in that each base transceiver station is arranged to

5   determine intermittently the proportions of each rate traffic in a cell controlled by the base transceiver station; and each base transceiver station is arranged to apply a variable threshold to the loading level in each cell.

Brief Description of the Drawings

The invention will be described with reference to the accompanying drawings in which:-

10   Figure 1 is a schematic diagram of a UMTS system;

Figure 2 indicates temporal loading variations in a telecommunication cells; and

Figure 3 is a graph of cumulative distribution functions of the instantaneous loading with different proportions of high data rate services.

Detailed Description of the Preferred Embodiment

15   In the Universal Mobile Telephone System illustrated in Figure 1, a Core Network (CN)10 has an interface 12 with a plurality of Radio Network Controllers (RNC) 14, 16, each controlling a plurality of Base Transceiver Stations (BTS) 18, 20, 22, 24. For simplicity only two RNCs each controlling two BTSs are shown. The BTSs interface through a radio interface 28 with a number of mobile users 30, 32.

20   Each BTS 18, 20, 22, 24 is arranged to monitor the loading in the telecommunications cell it controls. Referring now to Figure 2, in each cell there is a noise floor F, present when no users are active, and each BTS measures the interference level above this floor, which is proportional to the load in its cell. The measurement is based on the Received Signal Strength Indicator RSSI which gives a measure of the total interference in a cell. Each BTS has a current

25   load limit and if this limit is reached, the next request for resource, i.e. for a new connection to a mobile, is refused by the BTS.

If the traffic in the cell is voice, the actual loading varies relatively little in the short term, as indicated in Figure 2 by the line V. It is therefore possible to set a fixed limit L which will rarely be exceeded by voice traffic. Since the loading variations in the pure voice case are

30   minimal, this threshold translates to a fixed number of maximum allowed trunks, hence users.

If however the traffic is a mixture of voice and data, as shown by the line M there may be substantial periods when actual instantaneous loading would exceed the fixed loading threshold limit as well as periods during which traffic is well below the fixed limit. This is due to the

bursty nature of high rate users as well as the low spreading gain associated with high rate channels. During the periods of increased loading above line L, (the threshold), some users will be blocked or dropped in the middle of their calls, making the probability of blocking higher as the time spent above the line L is longer. This means that a lower loading threshold L' must be

5   set in such a way that the system will operate below the required loading level L. Thus when the system is carrying homogeneous traffic it will operate at a lower loading level, making the system less efficient. Line F indicates the noise floor.

In the inventive method and apparatus, a dynamic limit is set which varies in accordance with the proportion of high rate terminals which are active in a particular telecommunications

10   cell.

Figure 3 is a plot of the modelled Cumulative Distribution Functions (CDF) of loading in a cell with different fractions of high and low data rate services.

The dynamic traffic was modelled using a Poisson arrival rate and inverse exponential holding time using the Inverse Transfer Method. The CDF for the Poissonious and inverse

15   exponential distributions was used to find the number of arrivals and the values for initial holding times. The results presented here over a period of 10,000 seconds with 1 second sampling time.

Two types of service were simulated, 8kbps voice with 0.5 activity and 144kbps data with 1.0 activity. Four different mixes were modeled and the four plots show the CDFs for no high data rate service and for 10%, 20% and 30% high data rate services. A value of 10 dB

20   loading threshold (interference level above the noise floor) was used in the model.

Figure 3 shows that for pure voice traffic, shown by the chain-dotted line, the instantaneous loading rarely exceeds the 10dB threshold. For 10% high data rate and 90% voice, shown by the dotted line, there is some loading which exceeds the threshold, while for 20% high data rate (broken line) and 30% high data rate (full line) the threshold is highly likely to be

25   exceeded.

The loading values have a wide distribution; if a requirement is set that the system should be loaded below 10dB for a certain percentage of time, another threshold higher than 10dB should be set.

For example, suppose a threshold must be loaded below 10dB 99.9% of the time, for the

30   10% high data rate loading; the threshold then needs to be decreased from 10dB to 10-0.9 = 9.1dB.

By extensive simulation, it is possible to find the back-off values for all possible mixes of traffic.

Instead of simply setting a fixed threshold which is appropriate for a situation in which many high data rate terminals are active, it is now proposed that a dynamic threshold is set, depending on the actual mixture of active terminals in a cell. This information is already available for each cell in each BTS 18, 20, 22, 24 via the measurements of RSSI (Received

5   Signal Strength Indicator), but is currently not used in the way now proposed.

Thresholds can be selected so that, for the traffic mix currently applicable, traffic is below the threshold for a selected proportion of the time. A stable system can then be provided when there is a higher proportion of high data rate users, while allowing a greater number of connections during periods when fewer high data rate users are active.

10   An appropriate position for the setting of a dynamic loading threshold is within each RNC 14, 16. A mobile in a cell controlled by a BTS consumes some of the loading in its serving cell as well as in neighboring cells, so for effective control, a set of BTSs should be controlled, and allocated thresholds, by the controlling RNC. A cell currently experiencing a loading peak can then be allocated appropriate resource, but is also returned to a more stable condition as soon

15   as the loading peak is reduced.

In such an arrangement, each BTS 18, 20, 22, 24 will send intermittently to its controlling RNC 14, 16 a signal indicating the proportions of high and low data rate users currently active within a cell controlled by that BTS.. The RNC 14, 16 can then intermittently allocate to the BTSs it controls an appropriate loading threshold, taking into account the traffic in

20   cells controlled by adjacent BTSs. The periods between the intermittent signaling and allocating is selected to be appropriate to the network. The RNC can maintain a table of threshold values for specific mixes of services, such as those illustrated in Fig. 3, and can select a threshold for a cell to maintain optimum network operation.